

AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. – 26. (Cancelled)

27. (Currently Amended) A droplet ejection apparatus having a driving circuit, a reciprocating mechanism and a plurality of droplet ejection heads each including a cavity filled with a liquid, a nozzle in communication with the cavity, an actuator, and a diaphragm that is displaced when the actuator is driven, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator by means of the driving circuit to change an internal pressure of the cavity while moving the plurality of droplet ejection heads relatively with respect to a droplet receptor by the reciprocating mechanism so that the ejected droplets land on the droplet receptor, the droplet ejection apparatus comprising:

an ejection failure detecting means for detecting unit which detects an ejection failure of the droplet ejected through each of the nozzles and causes thereof, the causes of the ejection failure that the ejection failure detecting meansunit can detect including: intrusion of an air bubble into the cavity; thickening of the liquid in the vicinity of the nozzle due to drying; and adhesion of paper dust in the vicinity of an outlet of the nozzle, wherein the ejection failure detecting meansunit being-is constructed to detect a residual vibration of the diaphragm and then determine an ejection failure and a cause thereof based on a vibration pattern of the detected residual vibration of the diaphragm;

a counting means for counting unit which counts the number of ejection failures detected by the ejection failure detecting meansunit; and

a recovery means for carrying unit which carries out recovery processing for the droplet ejection heads to eliminate the cause of the ejection failure of the droplet;

wherein the ejection failure detecting meansunit detects the ejection failure with respect to a droplet ejection operation of each droplet ejected through the nozzles when the plurality of droplet ejection heads eject the droplets onto the droplet receptor, and wherein, in the case where the number of ejection failures with respect to the droplet receptor counted by the counting meansunit exceeds a predetermined reference value, the droplet ejection apparatus interrupts the ejection of the droplets onto the droplet receptor and make-makes the recovery meansunit carry out the recovery processing in accordance with the cause of the ejection failure;

the ejection failure detecting unit includes a judging unit which judges a cause of the ejection failure in the case where it is determined that there is the ejection failure of the droplets in the droplet ejection heads based on the vibration pattern of the residual vibration of the diaphragm;

the vibration pattern of the residual vibration of the diaphragm includes a cycle of the residual vibration; and

the judging unit judges that: an air bubble has intruded into the cavity in the case where the cycle of the residual vibration of the diaphragm is shorter than a predetermined range of cycle; the liquid in the vicinity of the nozzle has thickened due to drying in the case where the cycle of the residual vibration of the diaphragm is longer than a predetermined threshold; and paper dust is adhering in the vicinity of the outlet of

the nozzle in the case where the cycle of the residual vibration of the diaphragm is longer than the predetermined range of cycle and shorter than the predetermined threshold.

28. (Original) The droplet ejection apparatus as claimed in claim 27, wherein the reference value is changeable.

29. (Original) The droplet ejection apparatus as claimed in claim 28, wherein the droplet ejection apparatus has a plurality of operation modes that respectively correspond to reference values different from each other, and is adapted to be able to select any one of the operation modes.

30. (Currently Amended) The droplet ejection apparatus as claimed in claim 27, wherein the droplet ejection apparatus is adapted to confirm whether or not the ejection failure is eliminated through a detecting operation by the ejection failure detecting meansunit after the recovery meansunit carried out the recovery processing in accordance with the cause of the ejection failure.

31. (Currently Amended) The droplet ejection apparatus as claimed in claim 30, wherein the detecting operation by the ejection failure detecting meansunit for the confirmation is carried out at a droplet ejection operation in a flushing process for the nozzle.

32. (Currently Amended) The droplet ejection apparatus as claimed in claim 30, wherein the droplet ejection apparatus resumes the remaining ejection operation of the droplets onto the droplet receptor after carrying out the detecting operation by the ejection failure detecting meansunit for the confirmation.

33. (Currently Amended) The droplet ejection apparatus as claimed in claim 30, further comprising a droplet receptor transporting meansunit which carries out discharge and feed of the droplet receptor;

wherein the droplet ejection apparatus is adapted to operate the droplet receptor transporting meansunit to discharge the droplet receptor from and feed another droplet receptor to the droplet ejection apparatus to carry out a new and same droplet ejection operation with respect to the fed droplet receptor after carrying out the detecting operation by the ejection failure detecting meansunit for the confirmation.

34. (Currently Amended) The droplet ejection apparatus as claimed in claim 30, wherein, in the case where the ejection failure is detected through the detecting operation by the ejection failure detecting meansunit for the confirmation, the recovery meansunit carries out the recovery processing again.

35. (Currently Amended) The droplet ejection apparatus as claimed in claim 34, wherein, in the case where the recovery meansunit carries out the recovery processing again when the ejection failure was detected through the detecting operation

by the ejection failure detecting meansunit for the confirmation, the recovery meansunit carries out the recovery processing in accordance with the cause of the ejection failure.

36. (Currently Amended) The droplet ejection apparatus as claimed in claim 27, wherein the recovery meansunit includes: a wiping means for carrying unit which carries out a wiping process in which a nozzle surface of the droplet ejection heads where the nozzles are arranged is wiped with a wiper; a flushing means for carrying-unit which carries out a flushing process by which the droplets are preliminarily ejected through the nozzles by driving the actuator; and a pumping means for carrying unit which carries out a pump-suction process with the use of a pump connected to a cap that covers the nozzle surface of the droplet ejection heads.

37. (Currently Amended) The droplet ejection apparatus as claimed in claim 27,

wherein the recovery meansunit carries out the pump-suction process by the pumping meansunit in case of the intrusion of an air bubble, the flushing process by the flushing meansunit or the pump-suction process by the pumping meansunit in case of the thickening of the liquid due to drying, and at least the wiping process by the wiper in case of the adhesion of paper dust.

38 - 41. (Cancelled)

42. (Withdrawn - Currently Amended) The droplet ejection apparatus as claimed in claim 27, wherein the ejection failure detecting meansunit includes an oscillation circuit and the oscillation circuit oscillates in response to an electric capacitance component of the actuator that varies with the residual vibration of the diaphragm.

43. (Withdrawn - Currently Amended) The droplet ejection apparatus as claimed in claim 42, wherein the ejection failure detecting meansunit includes a resistor element connected to the actuator, and the oscillation circuit forms a CR oscillation circuit based on the electric capacitance component of the actuator and a resistance component of the resistor element.

44. (Withdrawn - Currently Amended) The droplet ejection apparatus as claimed in claim 42, wherein the ejection failure detecting meansunit includes an F/V converting circuit that generates a voltage waveform in response to the residual vibration of the diaphragm from a predetermined group of signals generated based on changes in an oscillation frequency of an output signal from the oscillation circuit.

45. (Withdrawn - Currently Amended) The droplet ejection apparatus as claimed in claim 44, wherein the ejection failure detecting meansunit includes a waveform shaping circuit that shapes the voltage waveform in response to the residual vibration of the diaphragm generated by the F/V converting circuit into a predetermined waveform.

46. (Withdrawn-Currently Amended) The droplet ejection apparatus as claimed in claim 45, wherein the waveform shaping circuit includes: a DC component eliminating ~~means for eliminating unit which eliminates~~ a direct current component from the voltage waveform of the residual vibration of the diaphragm generated by the F/V converting circuit; and a comparator that compares the voltage waveform from which the direct current component thereof has been eliminated by the DC component eliminating ~~means~~unit with a predetermined voltage value; and wherein the comparator generates and outputs a rectangular wave based on this voltage comparison.

47. (Withdrawn-Currently Amended) The droplet ejection apparatus as claimed in claim 46, wherein the ejection failure detecting ~~means~~unit includes a measuring ~~means for measuring unit which measures~~ the cycle of the residual vibration of the diaphragm based on the rectangular wave generated by the waveform shaping circuit.

48. (Withdrawn - Currently Amended) The droplet ejection apparatus as claimed in claim 47, wherein the measuring ~~means~~unit has a counter, and measures either a time between rising edges of the rectangular wave or a time between a rising edge and falling edge of the rectangular wave by counting pulses of a reference signal with the counter.

49. (Currently Amended) The droplet ejection apparatus as claimed in claim 27, further comprising:

a switching means ~~for switching unit which switches~~ a connection of the actuator from the driving circuit to the ejection failure detecting ~~means~~unit after carrying out the droplet ejection operation by driving the actuator.

50. (Currently Amended) The droplet ejection apparatus as claimed in claim 49, further comprising one or more ejection failure detecting meansunits and one or more switching meansunits;

wherein the switching meansunit corresponding to the droplet ejection head that has carried out the droplet ejection operation switches the connection of the actuator from the driving circuit to the corresponding ejection failure detecting meansunit, and then the switched ejection failure detecting meansunit detects an ejection failure of the droplets.

51. (Original) The droplet ejection apparatus as claimed in claim 27, wherein the actuator includes an electrostatic actuator.

52. (Original) The droplet ejection apparatus as claimed in claim 27, wherein the actuator includes a piezoelectric actuator having a piezoelectric element and using a piezoelectric effect of the piezoelectric element.

53. (Currently Amended) The droplet ejection apparatus as claimed in claim 27, further comprising:

a storage means for storing unit which stores a cause of the ejection failure of the droplets detected by the ejection failure detecting meansunit in association with the nozzle for which the detection was carried out.

54. (Original) The droplet ejection apparatus as claimed in claim 27, wherein the droplet ejection apparatus includes an ink jet printer.

55. (New) A droplet ejection apparatus having a driving circuit, a reciprocating mechanism and a plurality of droplet ejection heads each including a cavity filled with a liquid, a nozzle in communication with the cavity, an actuator, and a diaphragm that is displaced when the actuator is driven, the droplet ejection head ejecting the liquid within the cavity through the nozzle in the form of droplets by driving the actuator by means of the driving circuit to change an internal pressure of the cavity while moving the plurality of droplet ejection heads relatively with respect to a droplet receptor by the reciprocating mechanism so that the ejected droplets land on the droplet receptor, the droplet ejection apparatus comprising:

an ejection failure detecting unit which detects an ejection failure of the droplet ejected through each of the nozzles and causes thereof, the causes of the ejection failure that the ejection failure detecting unit can detect including: intrusion of an air bubble into the cavity; thickening of the liquid in the vicinity of the nozzle due to drying; and adhesion of paper dust in the vicinity of an outlet of the nozzle, wherein the ejection

failure detecting unit is constructed to detect a residual vibration of the diaphragm and then determine an ejection failure and a cause thereof based on a vibration pattern of the detected residual vibration of the diaphragm;

a counting unit which counts the number of ejection failures detected by the ejection failure detecting unit; and

a recovery unit which carries out recovery processing for the droplet ejection heads which is one of different discrete recovery processings respectively corresponding to the causes of the ejection failure to thereby eliminate the cause of the ejection failure, wherein the one recovery processing is selected according to the cause of the ejection failure detected by the ejection failure detecting unit;

wherein the ejection failure detecting unit detects the ejection failure with respect to a droplet ejection operation of each droplet ejected through the nozzles when the plurality of droplet ejection heads eject the droplets onto the droplet receptor, and wherein, in the case where the number of ejection failures with respect to the droplet receptor counted by the counting unit exceeds a predetermined reference value, the droplet ejection apparatus interrupts the ejection of the droplets onto the droplet receptor and makes the recovery unit carry out the recovery processing in accordance with the cause of the ejection failure.